

國立臺北大學自然資源與環境管理研究所  
111 學年度第二學期 『資源管理與環境系統分析』

課程講義(14)：非線性規劃與演算法  
Nonlinear Programming and Algorithms

- NONLINEAR PROGRAMMING -- INTRODUCTION
  - Local Optima vs. Global Optima
  - Convexity and Convex Programming
    - ⇒ Convexity of a Function: Convex, Concave and Un-determinant
    - ⇒ Convex Region vs. Non-convex Region
  - Analytical Solutions vs. Numerical Solutions
    - ⇒ Linearization of Nonlinear Objective Function => May not be necessary nowadays!
    - ⇒ Software Packages => Lingo, Euler Math Toolbox, Excel Solver Add-in, etc.
  - Nonlinear Programming (Chapter 13) in Applied Mathematical Programming (<http://web.mit.edu/15.053/www/AMP-Chapter-13.pdf>)
- UNCONSTRAINED OPTIMIZATION
  - Minima, Maxima and Saddle Points
    - ⇒ Necessary Conditions and Sufficient Conditions
  - Gradient of a Function (First Derivatives)
  - Hessian Matrix (Second Derivatives)
    - ⇒ Positively Definite: All the Eigenvalues are Positive
- LAGRANGE MULTIPLIERS AND OTHER METHODS
  - Lagrange Multiplier Method
    - ⇒ Constraints with All Equalities
    - ⇒ Properties of the Lagrange Multipliers
  - Kuhn-Tucker Conditions: Constraints with Inequalities
  - Gradient Search Procedure (Greedy) => Danger of Being Trapped at Local Optima
  - Applying Maximum Entropy Principle to Solving the Unfair Dice Problem
- ALGORITHMS FOR NONLINEAR PROGRAMS
  - Numerical Methods (Chang, 2002, Chap.5)
    - ⇒ Newton Method, Conjugative Direction and Conjugative Gradient Methods
  - Heuristic Algorithms => Soft Computation => Emulation of Natural Phenomena
    - ⇒ Artificial Neural Network; Genetic Algorithms
    - ⇒ Simulated Annealing; Tabu Search
    - ⇒ Ant Search, Ant Colony Algorithm, Swarm Intelligence, etc.
  - Optimization Algorithms (Wikipedia)
    - ⇒ Simplex Algorithm of George Dantzig, designed for linear programming
    - ⇒ Interactive Methods: Newton's method, Sequential quadratic programming...

⇒ Heuristic (Metaheuristic) Algorithms (<https://en.wikipedia.org/wiki/Metaheuristic>)

- Mayfly Optimization Algorithm
- Memetic algorithm
- Differential evolution
- Evolutionary algorithms
- Dynamic relaxation
- Genetic algorithms
- Hill climbing with random restart
- Nelder-Mead simplicial heuristic
- Particle swarm optimization
- Gravitational search algorithm
- Simulated annealing
- Stochastic tunneling
- Tabu search
- Forest Optimization Algorithm

<https://zh.wikipedia.org/zh-tw/元启发算法>

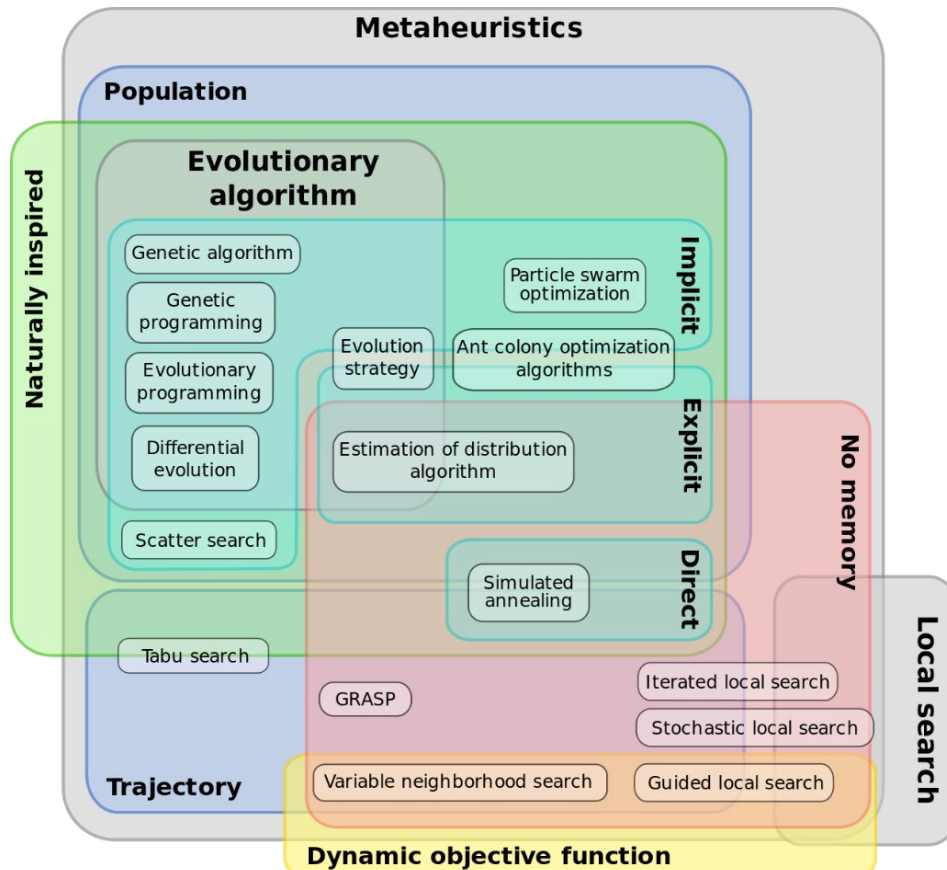
演算法

- 模擬退火法 (Simulated annealing algorithm, SA)
- 社會認知算法 (Social cognitive optimization, SCO)
- 簡化群體演算法 (Simplified swarm optimization, SSO)
- 調和搜尋演算法 (Harmony search, HS)
- 水循環算法 (Water cycle algorithm, WCA)
- 汽車跟蹤最佳化演算法 (Car tracking optimization algorithm)

仿生元啟發式演算法

- 基因/遺傳演算法 (Genetic algorithm, GA)
- 粒子群演算法 (Particle swarm optimization, PSO)
- 蟻群演算法 (Ant colony optimization, ACO)
- 布穀鳥搜索算法 (Cuckoo Search, CS)
- 蝙蝠算法 (Bat algorithm, BA)

- 螢火蟲算法 (Firefly algorithm, FA)
- 猴群演算法 (Monkey algorithm)
- 獅子演算法 (Lion optimization algorithm, LOA)
- 人工蜂群演算法 (Artificial bee colony, ABC)
- 病毒最佳化演算法 (Virus Optimization Algorithm, VOA)
- 飛蛾搜尋演算法 (Moth search algorithm)
- 鯊魚氣味演算法 (Shark smell optimization, SSO)
- 蚯蚓最佳化演算法 (Earthworm optimization algorithm, EWA)
- 帝王企鵝演算法 (Emperor Penguins Colony, EPC)
- 抹香鯨算法 (Sperm whale algorithm, SWA)
- 人類精神搜索 (Human mental search, HMS)
- 海洋掠食者算法 (Marine Predators Algorithm, MPA)
- 狩獵搜索 (Hunting search, HuS)
- 遷徙鳥類最佳化 (Migrating birds optimization, MBO)



[https://en.wikipedia.org/wiki/Metaheuristic#/media/File:Metaheuristics\\_classification.svg](https://en.wikipedia.org/wiki/Metaheuristic#/media/File:Metaheuristics_classification.svg)